(g) Run the test cycle specified in the standard-setting part and collect the test data.

(h) As soon as practical after the test cycle is complete, analyze the bag samples.

§ 1065.530 Test cycle validation criteria.

(a) *Steady-state emission testing.* Make sure your engine's speeds and loads stay within ±2 percent of the set point during the sampling period.

(b) *Transient emission testing performed by EPA.* Emission tests must meet the specifications of this paragraph (b). Otherwise, they do not comply with the test cycle requirements of the standard-setting part, unless we determine the cause of the failure to meet these specifications is related to the engine rather than the test equipment.

(1) *Shifting feedback signals.* The time lag between the feedback and reference-cycle values may bias results. To reduce this effect, you may advance or delay the entire sequence of engine-speed and torque-feedback signals with respect to the reference sequence for speed and torque. If you shift the feedback signals, you must shift speed and torque the same amount in the same direction.

(2) *Calculating brake kilowatt-hour emissions.* Calculate brake kilowatt-hour emissions for each pair of feedback values recorded for engine speed and torque. Also calculate the reference brake kilowatt-hour for each pair of reference values for engine speed and torque. Calculate to five significant figures.

(3) *Performing regression-line analysis.* Perform regression analysis to calculate validation statistics as follows:

(i) Perform linear regressions of feedback value on reference value for speed, torque, and brake power on 1 Hz data after the feedback shift has occurred (see paragraph (b)(1) of this section). Use the method of least squares, with the best-fit equation having the form:

$$y = mx + b$$

Where:

y = The feedback (actual) value of speed (rpm), torque (ft-lbs.), or brake power.

m = Slope of the regression line.

x = The reference value (speed, torque, or brake power).

b = The y-intercept of the regression line.

(ii) Calculate the standard error of estimate (SE) of y on x and the coefficient of determination (r^2) for each regression line.

(iii) For a valid test, make sure the feedback cycle's integrated brake kilowatt-hour is within 5 percent of the reference cycle's integrated brake kilowatt-hour. Also, ensure that the slope, intercept, standard error, and coefficient of determination meet the criteria in the following table (you may delete individual points from the regression analyses, consistent with good engineering judgment):

TABLE 1 OF § 1065.530—STATISTICAL CRITERIA FOR VALIDATING TEST CYCLES

	Speed	Torque	Power
1. Slope of the regression line (m).	0.980 to 1.020	0.880 to 1.030	0.880 to 1.030.
2. Y intercept of the regression line (b).	$\lvert b \rvert \le 40$ rpm	$\lvert b \rvert \le 5.0$ percent of maximum torque from power map.	$\lvert b \rvert \le 3.0$ percent of maximum torque from power map.
3. Standard error of the estimate of Y on X (SE).	100 rpm	15 percent of maximum torque from power map.	10 percent of maximum power from power map.
4. Coefficient of determination (r^2).	$r^2 \ge 0.970$	$r^2 \ge 0.900$	$r^2 \ge 0.900$.

(c) *Transient testing performed by manufacturers.* Emission tests that meet the specifications of paragraph (b) of this section satisfy the standard-setting part's requirements for test cycles. You may ask to use a dynamometer that cannot meet those specifications, consistent with good engineering practice. We will approve your request as long as using the alternate dynamometer does not affect your ability to show that you comply with all applicable emission standards.

EFFECTIVE DATE NOTE: At 69 FR 39261, June 29, 2004, § 1065.530 is amended by revising paragraph (b)(3)(iii) and adding paragraphs (d) and (e), effective Aug. 30, 2004. For the convenience of the user, the revised text is set forth as follows:

§ 1065.530 Test cycle validation criteria.

* * * * *

(b) * * *

(3) * * *

(iii) For a valid test, make sure the feedback cycle's integrated brake kilowatt-hour is within 5 percent of the reference cycle's integrated brake kilowatt-hour. Also, ensure that the slope, intercept, standard error, and coefficient of determination meet the criteria in the following tables (you may delete individual points from the regression analyses, consistent with paragraph (e) of this section and good engineering judgment):

TABLE 1 OF § 1065.530.—STATISTICAL CRITERIA FOR VALIDATING TEST CYCLES FOR SPARK-IGNITION ENGINES

	Speed	Torque	Power
1. Slope of the regression line (m).	0.950 to 1.030	0.830 to 1.030	0.880 to 1.030.
2. Y intercept of the regression line (b).	|b| ≤ 50 rpm	|b| ≤ 5.0 percent of maximum torque from power map.	|b| ≤ 3.0 percent of maximum torque from power map.
3. Standard error of the estimate of Y on X (SE).	100 rpm	15 percent of maximum torque from power map.	10 percent of maximum power from power map.
4. Coefficient of determination (r^2).	$r^2 \geq 0.970$	$r^2 \geq 0.880$	$r^2 \geq 0.900$.

TABLE 2 OF § 1065.530.—STATISTICAL CRITERIA FOR VALIDATING TEST CYCLES FOR COMPRESSION-IGNITION ENGINES

	Speed	Torque	Power
1. Slope of the regression line (m).	0.950 to 1.030	0.830 to 1.030 (hot); 0.77 to 1.03 (cold).	0.890 to 1.030 (hot); 0.870 to 1.030 (cold).
2. Y intercept of the regression line (b).	|b| ≤ 50 rpm	|b| ≤ 20 Nm or |b| ≤ 2.0 percent of maximum torque from power map, whichever is greater.	|b| ≤ 4.0 kW or |b| ≤ 3.0 percent of maximum torque from power map, whichever is greater.
3. Standard error of the estimate of Y on X (SE).	100 rpm	13 percent of maximum torque from power map.	8 percent of maximum power from power map.
4. Coefficient of determination (r^2).	$r^2 \geq 0.970$	$r^2 \geq 0.880$ (hot); $r^2 \geq 0.850$ (cold);.	$r^2 \geq 0.910$ (hot); $r^2 \geq 0.850$ (cold).

* * * * *

(d) *Transient testing with constant-speed engines.* For constant-speed engines with installed governor operating over a transient duty cycle, the test cycle validation criteria in this section apply to engine-torque values but not engine-speed values.

(e) *Omissions.* You may omit the following points from duty cycle statistics calculations:

(1) Feedback torque and power during motoring reference commands when operator demand is at its minimum.

(2) Feedback speed and power during idle-speed oscillations, if all the following are true:

(i) Reference command is 0% speed and 0% torque.

(ii) Operator demand (*i.e.*, throttle) is at its minimum.

(iii) Absolute value of feedback torque is less than the sum of the reference torque plus 2% of the maximum mapped torque.

(3) Feedback power and either speed or torque for a given point when approaching maximum demand, if all the following are true:

(i) Operator demand (*i.e.*, throttle) is at its maximum.

(ii) Either feedback speed is less than reference speed or feedback torque is less than reference torque, but both are not less than their respective reference values.

(4) Feedback power and either speed or torque for a given point, when approaching minimum demand, if all the following are true:

(i) Operator demand (*i.e.*, throttle) is at its minimum.

(ii) Either feedback speed is greater than 105% of reference speed or feedback torque is greater than 105% of reference torque, but both are not greater than these values.

Subpart G—Data Analysis and Calculations

§ 1065.601 Overview.

This subpart describes how to use the responses on the analyzers and other meters to calculate final gram per kilowatt-hour emission rates.

NOTE: Volume and density values used in these calculations are generally corrected to standard conditions of 20°C and 101.3 kPa.)

§ 1065.605 Required records.

Retain the following information for each test:

(a) Test number.

(b) System or device tested (brief description).

(c) Date and time of day for each part of the test schedule.

(d) Test results.

(e) Operator's name.

(f) Engine: ID number, manufacturer, model year, emission standards, engine family, basic engine description, fuel system, engine code, and idle speed, as applicable.

(g) Dynamometer: Dynamometer identification, records to verify compliance with the duty cycle requirements of the test.

(h) Gas analyzers: Analyzer bench identification, analyzer ranges, recordings of analyzer output during zero, span, and sample readings.

(i) Recorder charts: Test number, date, identification, operator's name, and identification of the measurements recorded.

(j) Test cell barometric pressure, ambient temperature, and humidity as required. (Some test systems may require continuous measurements; others may require a single measurement, or measurements before and after the test.)

(k) Temperatures: Records to verify compliance with the ambient temperature requirements throughout the test procedure.

(l) CFV–CVS: Total dilute exhaust volume (Vmix) for each phase of the exhaust test.

(m) PDP–CVS: Test measurements for calculating the total dilute exhaust volume (Vmix), and the Vmix for each phase of the exhaust test.

(n) The humidity of the dilution air.

NOTE: If you do not use conditioning columns, this measurement is not necessary. If you use conditioning columns and take the dilution air from the test cell, you may use the ambient humidity for this measurement.

§ 1065.610 Bag sample analysis.

(a) Zero the analyzers and obtain a stable zero reading. Recheck after tests.

(b) Introduce span gases and set instrument gains. To avoid errors, span and calibrate at the same flow rates used to analyze the test sample. Span gases should have concentrations equal to 75 to 100 percent of full scale. If gain has shifted significantly on the analyzers, check the calibrations. Show actual concentrations on the chart.

(c) Check zeroes; if necessary, repeat the procedure in paragraphs (a) and (b) of this section.

(d) Check flow rates and pressures.

(e) Measure HC, CO, CO_2, and NO_X concentrations of samples.

(f) Check zero and span points. If the difference is greater than 2 percent of full scale, repeat the procedure in paragraphs (a) through (e) of this section.

§ 1065.615 Bag sample calculations.

(a) Calculate the dilution factor. The dilution factor is the ratio of the total volume of the raw exhaust to the total volume of the diluted exhaust. It is calculated as 134,000 divided by the sum of the diluted ppmC concentrations of carbon-containing compounds in the exhaust, as follows:

$$DF = 134{,}000/(CO_{2sample}+THC_{sample}+CO_{sample}),$$

Where:

$CO_{2sample}$ and CO_{sample} are expressed as ppm, and THC_{sample} is expressed as ppmC.

(b) Calculate mass emission rates (g/test) for the transient segment using the general equation in paragraph (b)(1) of this section:

(1) The general equation is:

Emission rate = (total dilute exhaust flow volume)(ppm)(density factor)/10^6

$$M_x = (V_{mix})(C_i)(f_{di})/10^6$$

Where:

M_x = Mass emission rate in g/test segment.